TOOL DIE MACHINE
PROGRESS
THE NATIONAL TOOL AND DIE JOURNAL

TOOLS, DIES, JIGS, FIXTURES, MOULDS, GAGES, MACHINES
Design and Engineering
PRECISION SPECIALTIES
STAMPING and PARTS PRODUCTION
Official Publication
Special Tool, Die & Machine Shop Industry

JULY,
1937

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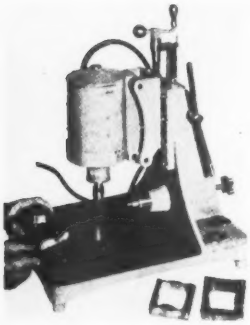

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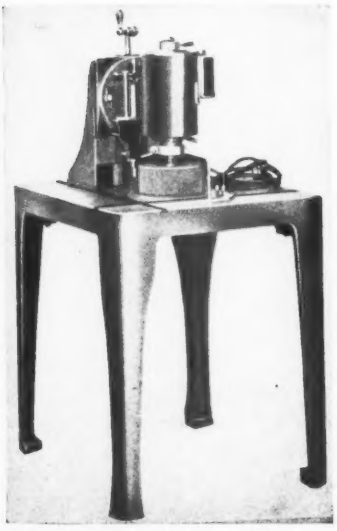

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THE NATIONAL TOOL AND DIE JOURNAL

Published in the interest of Manufacturers and Users of

CUSTOM-BUILT TOOLS, DIES, MACHINES AND ACCESSORIES

GEORGE J. HUEBNER . . . *Publisher and Editor*
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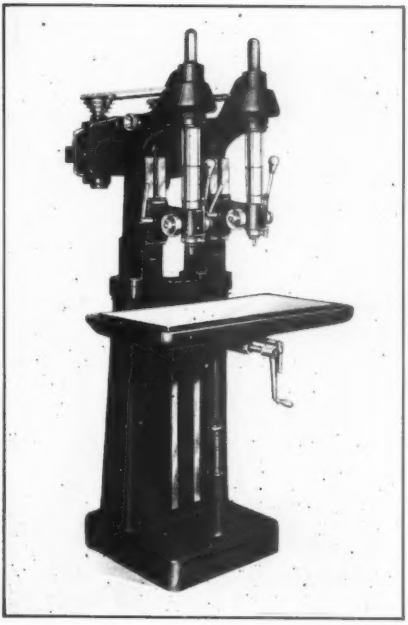

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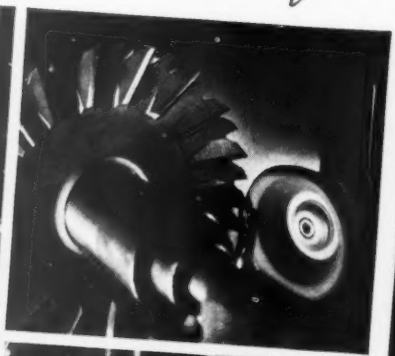

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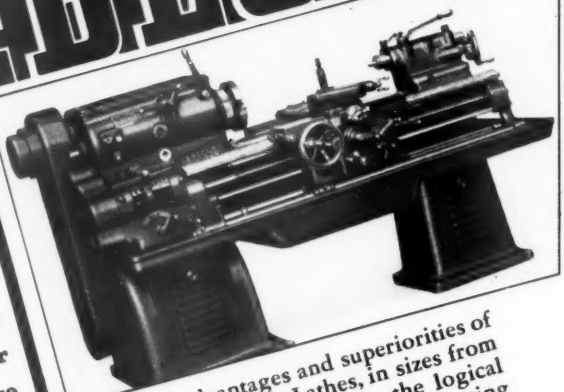

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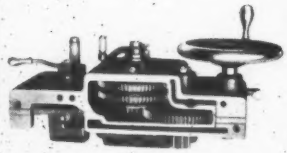

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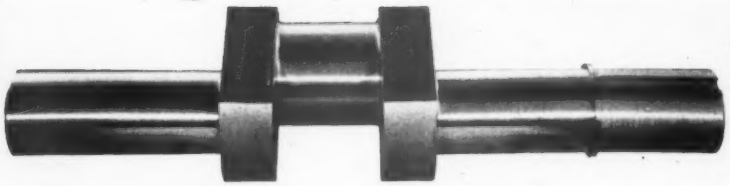

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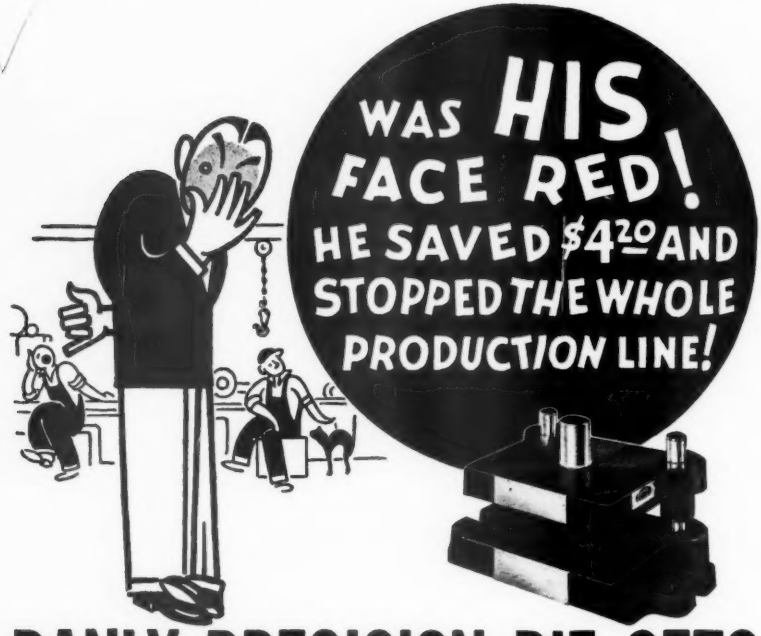

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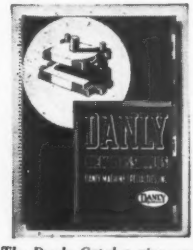

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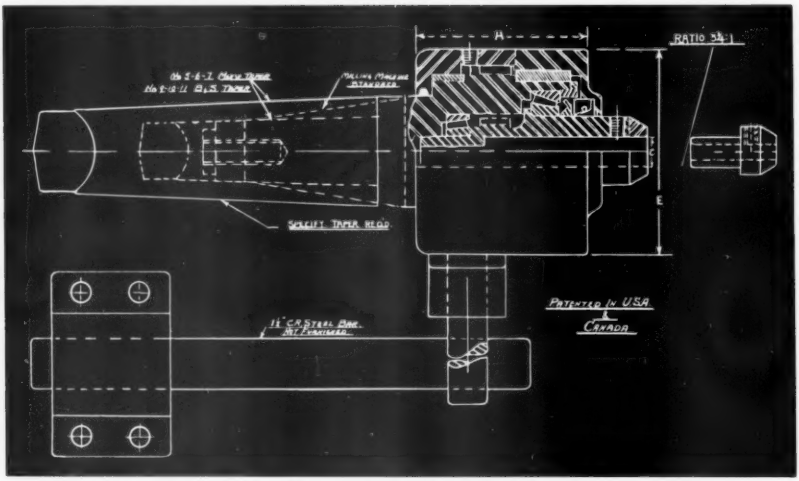

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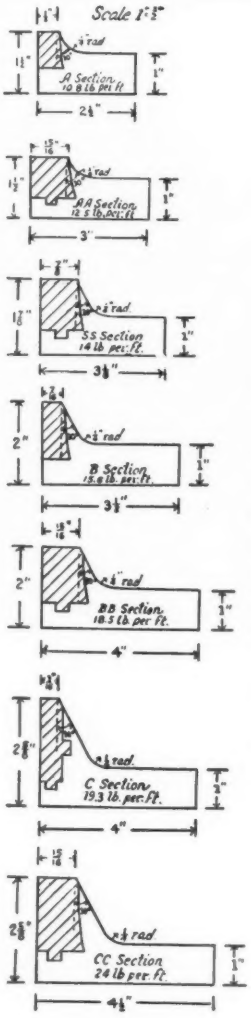

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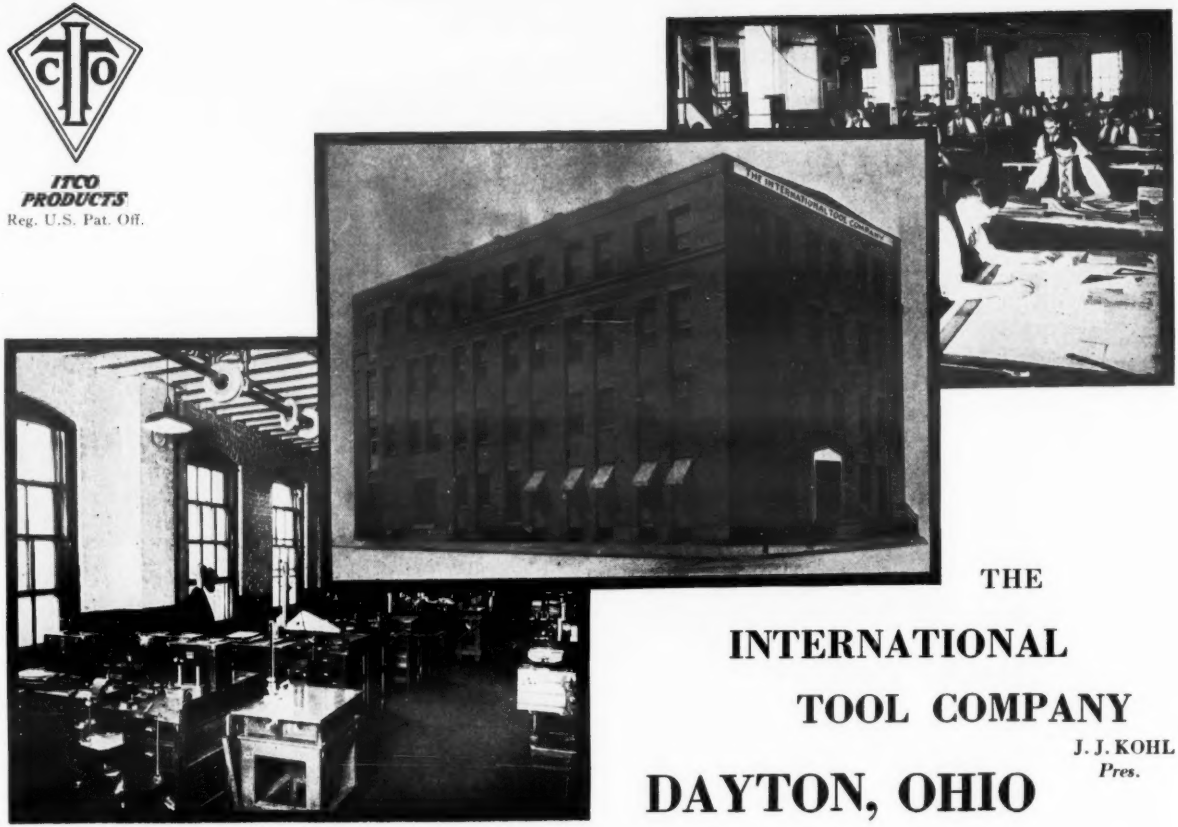

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NOTE — There will appear on these pages, from time to time, various "Thoughts" pertinent to business in general and the Tool and Die Industry in particular. We invite comment.

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Tool • Die • Machine **PROGRESS**

The National Tool and Die Journal

July, 1937 Vol. 3, No. 4

Modern Tolerance Requirements and Their Scientific Determination

By HILDING TORNEBOHM

A. B. Svenska Kullagerfabriken

Goteborg, Sweden

This article is a portion of the Third Calvin W. Rice Memorial Lecture delivered before a meeting of The American Society of Mechanical Engineers, and permission of the Society to reprint is gratefully acknowledged.—The Editor.

IT IS now about thirty years since the mechanical engineers of the world were startled by the accuracy obtainable in the new Johansson blocks, which opened for the whole industrial world the possibility of accurate measurements to a degree of precision which before this time had been considered impossible. At the time these remarkable blocks were invented 0.001 in. was considered an extremely accurate measurement. Today we speak of 0.0001 in. and less with a general understanding of what it may be. It has been this development in the technique of measurement which has made possible mass production and complete interchangeability of parts. As a specific example, what would the automobile industry be today without the possibility of part interchangeability? We take this matter of interchangeability so casually that we forget the difficulties which would exist if the possibilities of accurate measurements were nonexistent.

We have now come to a point where the possibility of making accurately the required parts actually exceeds our ability to measure them with the proper degree of precision. The reason for this is that the development of measuring equipment, such as plug gages, snap gages, micrometers, and bore gages, which are generally used in industry today, has not been improved to any great extent over the past 25 years, although, of course, such gages are today built of better material, with greater accuracy, and generally have a much longer life. The point I should like to bring out, however, is the fact that, with few exceptions, the measuring equipment in the average plant of today is far inferior basically to the machine equipment. We may say to ourselves that our measuring equipment is entirely satisfactory. I am fully convinced, however, that many of the apparently inexplicable failures which occur are due, to a smaller or larger extent, to the imperfections which are not readily determined by our average measuring devices.

From checking a number of gages we knew that inaccuracies existed in the products of European gage manufacturers, and in the preparation of this paper it seemed to me desirable to determine whether such inaccuracies might also be present in gages made in the United States. A number of gages were obtained from the best known manufacturers in this country and found to be excellent. Nevertheless, they exhibited the same characteristic errors. The overall variations on the part of the various gage manufacturers was as much as plus and minus 0.0001 in., both on the maximum and minimum sides, and, what is most important, no allowance was made for wear. Similarly, in the case of

snap gages, the variations were 0.0001 in., and no allowance was provided in the adjustments to the actual weight of the snap gage itself, the effect of which may be to change the actual dimension by as much as 0.0002 in. in a gage of ordinary size. We must, therefore, conclude that the same conditions which have existed in Europe also exist in this country.

Let us, for a moment, get away from theory and consider an actual case as it exists in a manufacturing plant. If we have a shaft which on the drawing shall be within a tolerance of 1.5748 in. maximum and 1.5744 in. minimum, what shall we actually obtain? In the first place, let us consider measuring this shaft with a micrometer. We know that the micrometer will be handled differently by different workmen; that different pressures will be applied; that there may be variations between two micrometers; and that there may be wear in the micrometer screw itself. All of these factors will tend to give inaccurate readings, and I am safe in saying that the variations in the readings of two good inspectors with two different micrometers will vary from plus or minus 0.0001 in. to plus or minus 0.0002 in. Even with so broad a range, the inspectors must be of more than average ability. If, now, we consider stationary instruments, such as dial indicators, the accuracy will not be better unless special care is taken. There are many possibilities of error, i.e., errors in the indicator itself, and in the adjustment, pressure variations, and internal friction in the indicator. While no generalization can be made concerning these errors, nevertheless they may be of a large magnitude compared with the present small tolerances.

When we use snap gages an entirely new set of problems arises whether these gages are purchased from master gage builders or whether they are made by the user himself. There are, surprisingly, a number of complex questions such as where shall the limits of the wear apply, what shall be their range, what shall be the actual shape and finish of the measuring surface, and how shall the gages be handled. It is remarkable, but, nevertheless, a fact, that there are variations in snap gages due to a number of conditions which are uncontrollable in practice, affecting in turn the correct measurement of the piece involved.

If we have a production problem involving the measurement of a piece having a tolerance of a given amount, there is a possibility of obtaining a set of actual measurements quite different from the originally prescribed tolerances. Let us analyze what may occur by referring to Fig. 1*a*. We shall assume that we desire a particular piece to have an upper and lower limit as shown by the heavy line. Obviously, the first step is the determination of these measurements by block gages that have a very limited amount of error. In transferring the measurements to the reference gage, we have additional and larger inaccuracies. Another transfer, to the snap gage, gives a still greater and additional variation in the high and low limits. And finally, there is the check of the workpiece by the operator, which in turn results in still larger variations. The degree of *the tolerances on the tolerances on the tolerances*—if I may be permitted to use this phrase—is

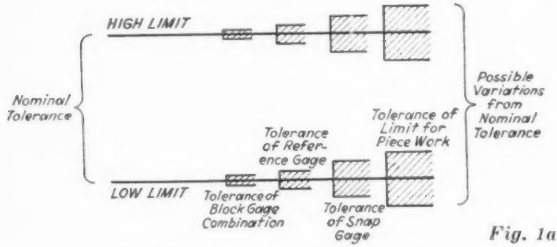

Fig. 1a

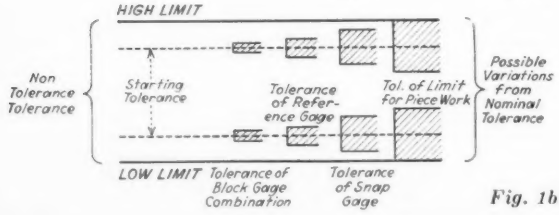

Fig. 1b

roughly indicated in the figure. If we are to maintain accurately the established tolerances, then quite a different procedure of measurement would be required, see Fig. 1*b*. Such a system is what in France is known as the *Systeme de l' Intransigeance*, which has always been the preferred system in that country.

It will then be necessary for us to begin with an entirely different set of starting tolerances on the block gages to obtain finally a variation not in excess of the established and required tolerance. Obviously, this would require extremely accurate original tolerance if indeed the degree of variation at the various steps were actually known, which is obviously quite unlikely. Furthermore, consideration must be given to the degree of wear which even tends to decrease the starting tolerance in comparison with the prescribed tolerance. It is for this reason that the International Standards Association has found the necessity for actually providing some tolerances on the tolerances, the magnitude of which has been definitely established, depending upon the characteristics of accuracy required. This approved system is familiar to engineers through official American publications.

So far I have discussed only the errors that may arise, and the question can naturally be asked, "Is there *any* proper type of measuring equipment and should not all present equipment be discarded?" Naturally, such a thought is farthest from my mind. I do think, however, that improvements can be made both in the present measuring equipment and in its method of use.

As to the proper type of measuring equipment, I am of the opinion, if I may use the experience of our own factory, that a combination of various types of measuring instruments will give the most satisfactory results. In our factory, for example, we use both dial indicators and fixed gages for production. Dial gages are easy to read and are inexpensive to use, and the problem of wear may be disregarded. However, in order to insure ourselves of proper measurements with dial indicators, we have found it necessary to standardize on one particular type, not necessarily because it is better than any other, but because the errors in the dial itself, and the measuring pressure, that is, the spring tension, are known to us and due allowance is made for them. It is our practice to use a diamond point lapped to a spherical surface of a 5-mm radius in order always to insure a minimum variation in reading due to variations in measuring points.

We use fixed gages in final inspection. Fixed gages have the advantages, first, that they are set to proper tolerances in the gage room by a mechanic who is more skillful than the machine operator would be and who has the advantage of using master gages and blocks for setup. Consequently, we are assured of greater accuracy. We have, with the use of a fixed gage, an entirely different method of checking the workpiece and, consequently, the errors which may not be detected from the dial indicator are determinable by the fixed gages.

We have found, therefore, that a combination of dial indicators in the shop and fixed gages for final inspection give us a double check-up, and is better than using either one or the other alone.

How may we improve the accuracy of our fixed gages?

I am convinced that there must be a difference in the method of measuring the "go" and "no-go" dimensions, whether it be for a bore or whether it be for a shaft. When we drive a spike, we use a sledge; for pulling it out we must use another type of tool. Similarly, when we measure "go" dimensions we must use one principle, but for the "no-go" dimension an entirely different principle. Earlier in this paper, I discussed briefly the importance of determining the following characteristics:

For holes

1 The diameter of the inscribed circle
2 The greatest existing diameter.

For the shaft

1 The diameter of the circumscribed circle
2 The smallest existing diameter.

It is impossible, due to *makro* (geometrical) errors, to measure a diametrical dimension with an ordinary plug gage, and yet, I think I am safe in saying that in this country, as well as most other countries, plug gages are generally used for both the "go" and "no-go" limits. In Germany, due to the recommendation of the International Stand-

(Continued on page 32)

Nineteen Standard Self-Holding Tapers to Replace Present Large Variety

By FREDERICK S. BLACKALL, Jr.
President, Special Tool, Die & Machine Shop Institute

We reproduce, with permission of the American Standards Association, a portion of the report of Technical Committee No. 3 which prepared the new American Standards for Machine Tapers. Mr. Blackall was Chairman of the Committee.

WITH its approval by the American Standards Association in March, 1937, a new and simplified series of self-holding or "slow" tapers becomes available to American industry. This should ultimately make possible a high degree of interchangeability of machine fittings, accessories, and tools, thus widening the field which the manufacturer of taper shank tools can cover with a basic minimum stock, and reducing the inventories which the tool user will have to carry in his tool cribs.

The new self-holding taper series embraces 19 different tapers, ranging in size when measured at the large diameter or gage line from 0.239 in. to 12 in. This series is so designed as to serve every purpose now covered by perhaps half a dozen different systems which include 60 to 100 or more individual tapers. The annual saving in dollars and cents to industry, from the point of view of both manufacturer and consumer through the use of this simplified standard, will be obvious.

Basically, the new taper series represents the adoption or adaptation of the best features of a number of the more widely used taper series already in existence. The new American Standard taper incorporates the following characteristics:

(*a*). Brown & Sharpe tapers Nos. 1, 2 and 3, each with a taper of ½ in. per foot, but re-numbered according to the decimal diameter at the gage line, respectively, .239 in., .299 in., and .375 in.

(*b*). Morse tapers Nos. 1, 2, 3, 4 and 5, with the taper per foot, as now correctly computed, rounded to three decimal places. These tapers will bear the original Morse numbers.

(*c*). A new taper between No. 4 and No. 5, designated as No. 4½, based on a slope of .623 in. per foot, with a diameter at the gage line of 1.500 in. This taper has the same slope as the Morse No. 4 and fills the long-felt gap between the 4 and 5 Morse tapers.

(*d*). An entirely new series of tapers of large size, each with a slope of ¾ in. to the foot, each designated by the number of tenths of an inch in the diameter at the gage line and ranging in size of the gage line diameter from 2 in. to 12 in.

The accompanying table sets forth the essential dimensions of the American Standard taper series and the origin of its three major divisions (see page 21).

The use of the taper fit for joining machine parts, or as a tool-holding or work-holding device, is a very old art. Probably the first step in an attempt to standardize taper dimensions was taken, however, by the Brown & Sharpe Manufacturing Company in 1860, when the well-known Brown & Sharpe series of taper standards was proposed. These tapers had a slope of ½ in. per foot, measured on the diameter, and covered a range of from .2391 in. to well over 3 in. Shortly afterwards, in 1862, the Morse Twist Drill & Machine Company developed a series of eight tapers, each with a slope of approximately ⅝ in. to the foot.

The use of these two systems promptly became international, and the Morse series in particular had become so widely adopted by the time engineering standardization was launched as a national or international activity, that it appears to have become part and parcel of every international standard which has been developed either here or abroad.

Errors Introduced

Unfortunately, however, at the time the Morse taper was originally proposed the accuracy attainable in manufacturing and measuring was so limited in the light of present-day practice that substantial errors were introduced in the taper per foot from the basic ⅝ in. standard. These errors have been perpetuated to this day, and undoubtedly account for the inconsistency which appears in the taper per foot among the eight tapers in the Morse series, as well as the variation which exists among the several Morse tables extant. . . . .

It is not surprising, then, that the standard as finally adopted represents a compromise, nor does it follow by any means that such a compromise is not highly desirable. Indeed, there was good reason for a compromise. . . . And so the committee was undoubtedly wise in resisting the temptation to develop a new taper of its own choosing, in lieu of the well-established Morse series of tapers, Nos. 1 to 5, inclusive. The inclusion of the new American standard No. 4½ taper is a recognition of the well-known gap which exists in this part of the Morse series, and it appears to be sound procedure to base the new 4½ taper on the Morse system as well, since it becomes substantially an integral part of it.

Adoption of the Brown & Sharpe 1, 2 and 3 tapers is a recognition of the better sticking or holding qualities of the ½ in. taper in small sizes, and, incidentally, eliminates the need of the Morse No. 0 taper, which has been dropped.

In the field of large tapers from 2 to 12 inches, inclusive, the committee had a better opportunity for original work. It did, however, borrow from the Sellers taper the ¾ in. slope, which had been employed in the Seller series since 1862 although in a substantially smaller size range. . . . .

Approval of the new taper by the American Standards Association lends it an authenticity which was always lacking in the old taper standards.

American Standard Self-holding Tapers
Basic, and Certain Calculated Dimensions

No. of Taper A	*Taper*[1] *per Foot* B	*Diameter*[1] *at Gage Line* C	*Diameter*[2] *at Small End* D	*Length*[2] *Gage Line to Small End* E	*Means of Driving and Holding*				*Origin of Series*
.239	0.500	0.239	0.200	$\frac{15}{16}$	Tongue Drive with Shank Held in by Friction				Brown and Sharpe Taper Series
.299	0.500	0.299	0.250	$1\frac{3}{16}$					
.375	0.500	0.375	0.312	$1\frac{1}{2}$					
1	0.600	0.475	0.369	$2\frac{1}{8}$		Tongue Drive with Shank Held in by Key			Morse Taper Series Rounded to three Decimal Places
2	0.600	0.700	0.571	$2\frac{5}{16}$					
3	0.602	0.938	0.778	$3\frac{3}{16}$					
4	0.623	1.231	1.020	$4\frac{1}{16}$					
4½	0.623	1.500	1.266	$4\frac{1}{2}$					
5	0.630	1.748	1.476	$5\frac{3}{16}$					
200	0.750	2.000	1.703	$4\frac{3}{4}$			Key Drive with Shank Held in by Key	Key Drive with Shank Held in by Draw-Bolt	¾ Inch per Foot Taper Series
250	0.750	2.500	2.156	$5\frac{1}{2}$					
300	0.750	3.000	2.609	$6\frac{1}{4}$					
350	0.750	3.500	3.063	7					
400	0.750	4.000	3.516	$7\frac{3}{4}$					
500	0.750	5.000	4.422	$9\frac{1}{4}$					
600	0.750	6.000	5.328	$10\frac{3}{4}$					
800	0.750	8.000	7.141	$13\frac{3}{4}$					
1000	0.750	10.000	8.953	$16\frac{3}{4}$					
1200	0.750	12.000	10.766	$19\frac{3}{4}$					

All dimensions are given in inches.
[1]Taper per foot and diameter at gage line (columns B and C) are basic dimensions.
[2]Dimensions in column D are calculated to three decimal places from the basic dimensions and are for reference only.

Why and How We Developed Our Master Hardness Conversion Chart

By GEO. H. PORTER, III and JOHN J. WALKER
Geo. H. Porter Heat Treating Company
Cleveland, Ohio

BACK in 1929 when our company moved into new quarters and a complete testing room with permanent records of testing results was established, it was frequently noted that customers would specify one of the various methods of testing, viz: Monotron, Rockwell, Scleroscope or Brinell although they might not have that particular equipment themselves. Thus they might have a Rockwell tester but specify in Scleroscope, due to the fact that their customer's blue print was so marked.

Our testing department had been using the Monotron almost exclusively for testing, but the difficulty came in when we would try to convert this reading into the type of reading our client specified. This continued until 1931 when, noting the differences in the conversion charts furnished by various steel manufacturers, we decided to try to make up a master chart.

It was found that an absolute comparison of the hardness readings obtained from one testing machine with those from another hardness tester could not be made on all kinds of steels with their different physical characteristics. For example, a hardened piece of 1.00% Carbon tool steel and a hardened piece of 18-4-1 high speed will Rockwell 65, and yet, the water hardening steel will Scleroscope 97 while the high speed steel will Scleroscope 87. Although there are such large differences in some individual cases, on the whole, our experience in testing about 400 grades of steel during the last several years indicated that a much closer comparison is possible and we have found our hardness conversion chart sufficiently accurate for all practical purposes.

The conversion data from approximately 429 Brinell and higher have been accumulated from tests on hardened and tempered highly alloyed steel such as high speed, high carbon-high chrome, oil-hardening and water-hardening steels. Under 429 Brinell our data has been confined for the most part to lower alloyed steels such as SAE or corresponding steels, although comparison tests were made on a number of tool steels.

In making the Brinell tests the surfaces were ground reasonably flat and free from coarse grinding. The depth of the grind was sufficient to be representative of the steel. The Brinell was pumped very slowly as it approached the 3000 Kg. load to avoid the possibility of "kicking" the gauge beyond that point. The impressions read were an average of the readings taken at right an-

(Continued on page 36)

Hardness Conversion Chart
(Approximate)

Dia. of Impr. 3000 kg. ld. 10 MM ball	Brinell	Rockwell "C"	Rockwell "B"	Monotron	Scl.	Dia. of Impr. 3000 kg. ld. 10 MM ball	Brinell	Rockwell "C"	Rockwell "B"	Monotron	Scl.
2.25	745	68	...	118	100	3.30	341	36	...	47	49
.....	....	67	...	112	98	3.35	331	35	...	45	47
2.30	712	66	...	108	95	3.40	321	34	...	44	46
2.35	682	65	...	104	92	3.45	311	33	...	42	45
.....	....	64	...	100	90	3.50	302	32	...	41	43
2.40	653	63	...	96	89	3.55	293	31	...	40	42
.....	....	62	...	93	87	3.60	285	30	...	39	41
2.45	627	61	...	91	86	3.65	277	29	...	38	40
2.50	601	60	...	88	83	3.70	269	28	...	37	39
.....	....	59	...	85	80	3.75	262	27	...	36	38
.....	....	58	...	83	79	3.80	255	25	...	34	37
2.55	578	57	...	81	78	3.85	248	24	100	34	36
.....	....	56	...	79	76	3.90	241	23	99	33	35
2.60	555	55	...	77	75	3.96	235	22	99	32	34
2.65	534	54	...	75	73	4.00	228	21	98	31	34
.....	....	53	...	73	72	4.05	223	20	97	30	33
2.70	514	52	...	71	71	4.10	217	19	96	29	32
.....	....	51	...	69	69	4.15	212	17	95	29	31
2.75	495	50	...	68	68	4.20	207	16	95	28	31
2.80	477	49	...	66	66	4.25	201	15	94	28	30
.....	....	48	...	64	65	4.30	197	13	93	27	29
2.85	461	47	...	62	64	4.35	192	12	92	26	29
2.90	444	46	...	60	62	4.40	187	11	91	26	28
2.95	429	45	...	59	60	4.45	183	10	90	25	28
3.00	415	44	...	57	58	4.50	179	9	89	25	27
3.05	401	42	...	55	57	4.60	170	8	87	23	26
3.10	388	41	...	53	56	4.70	163	6	85	21	23
3.15	375	40	...	51	54	4.80	156	4	83	20	23
3.20	363	39	...	50	52	4.90	149	2	81	19	22
3.25	352	38	...	48	50	5.00	143	0	79	18	21

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SPECIAL TOOL, DIE AND MACHINE SHOP INSTITUTE
A National Trade Association

Not How Cheap But How Good

An Editorial

THERE is developing among the buyers of custom-built Tools, Dies and Machines a marked tendency toward recognition of the fact that these highly important tools of high production should never be bought on a price basis alone.

More and more frequently we are apprised of instances wherein the production manufacturer and the contract TDM Shop have established a basis of mutual confidence which makes possible a much more satisfactory relationship of buyer and seller.

The designing, developing and building of special Tools and Dies and Machines is a business different from almost anything we know of. Why it is different and the reasons why users of these production "keystones" should recognize for their own profit that it is different, are unusually well set forth in a series of advertisements which have been appearing in Tool·Die·Machine PROGRESS.

These are the "A Thought" double-spread advertisements of the International Tool Company of Dayton, Ohio. They are more than the selling copy of an individual TDM builder; they are thought-provoking copy for all members of the TDM Industry.

In the first of the series, (October, 1936), J. J. Kohl, President of the International Tool Company, repeats that epical fable of Hakeem, the Wise One, who recites to the young man that profound truth that: "The Price Ingredient of every product—is the Honor and Integrity of him who makes it."

The buyer of Tools and Dies, and the builders of them, have much to think about here.

Mr. Kohl writes about Workmanship: (January issue) "To the owner—of a first class Tool and Die Shop, his standards are a vital, living thing, something he fights to maintain, moves heaven and earth to live up to. His ideals of workmanship permeate his entire organization, make a living laboratory of craftsmanship out of what would otherwise be just another tool shop."

When a Builder of Tools and Dies has demonstrated these ideals of workmanship in a practical way to a Buyer, then Mr. Kohl believes that the stage is set for "Stabilized Relations" between them. He says: (March issue) "The greatest satisfaction for the buyer and user of Dies, Jigs, Fixtures, Special Gages, etc., is obtained from Tool and Die sources when the buyer and the seller have a thoroughly mutual confidence in each other, the Tool and Die Shop able to rely on his customer to keep him supplied with a steady volume of work whenever it is available without fear that the business will be withdrawn upon the slightest pretext, and without the constant harassment of promiscuous and often unprincipled price competition, and the customer able to rely upon his Die and Tool source for prompt and reliable delivery service and workmanship in line with his standards; knowing that his requirements have been anticipated by close cooperation and capacity reserved accordingly; and knowing that he will not be let down in his hour of need. Such relations make for stabilization of business and employment."

Stabilization has so many concomitants of quality and character. Exactly as it brings to an individual the advantages of a greater freedom of thought and a wider horizon, so among the results to be realized by a manufacturer, in this case the Tool and Die Builder, is the opportunity to plan more confidently, to add to his organization men and machines which improve product and reduce cost.

Buyers of Tools, Dies and Machines will always have to take tooling costs into consideration but here again Mr. Kohl makes a suggestion the value of which must be readily realized by all who give it a moment's thought. We quote: (June issue) "The efficiency of modern tooling, from the standpoint of low cost and consistently accurate production, would be much enhanced if the ingenuity

SPECIAL TOOL, DIE AND MACHINE SHOP INSTITUTE

A National Trade Association

Institute Divisions Hold Meetings

IMPORTANT meetings of two Special Tool, Die & Machine Shop Institute local groups were held on Friday evening, June 25th.

The first scheduled was that of the Tool Manufacturers' Association which is the Southern Ohio Division of the Institute with headquarters in Dayton, Ohio. J. F. Deibel, President of the Modern Tool, Die & Machine Company of Columbus, Ohio is President; H. L. Neilson, Secretary.

Members of the Industry from Cincinnati, Columbus & Dayton were present for dinner at the Van Cleve Hotel. The purpose of the meeting was to discuss the labor situation in the TDM Industry, particularly as it existed in Southern Ohio.

The Secretary of the National Institute had been invited to attend and opened the discussion with a resumé of the demands which labor had made in other districts and the settlements which had been negotiated.

Questions and answers followed and the meeting became an interesting round-table session. The discussion was frank and apparently from the viewpoint that *each man's problems are every mans' problems.*

National Secretary Huebner's closing remarks epitomized the consensus of opinion:

"This one thing I urge upon you. Work together, cooperate with one another to the limit to avoid a strike in your district. Strikes are never profitable."

The Cleveland Meeting

On the evening of June 25th at the Allerton Hotel in Cleveland about 40 TDM Industry executives were present to discuss conditions in the Northern Ohio district.

It was an informal discussion under the direction of Joseph H. Lyons, President of the Northern Ohio Division. Hours, wages and general operating policies came up for discussion. Requirements of the National Labor Relations Act were presented in such form that every executive would be prepared to conform thereto and still be cognizant of his rights.

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and skill of the Tool and Die Engineer, Designer and Maker were given greater freedom to devise and originate better methods . . . The evolution of a new idea or a new combination of old ideas does not lend itself to limitation.

Imagination, thought and judgment are brain processes. Skill, ingenuity, experience—actions directed and controlled by the brain, the very essence of creative endeavor, are subject to extremely wide variations in their intensity and effectiveness because 'Nature' has so decreed. Successful creative effort requires perseverance and time, varying with the obstacles to be overcome and the happy break of a lucky thought.

These processes cannot be reduced to the level of time-studied manual production work where countless repetitions engender automatic action.

It appears timely to recognize the fundamental nature of tooling as the keystone of mechanical production appraising its value on ultimate savings rather than first cost."

You—builder of tools or user of them—who are reading this editorial undoubtedly agree with us now that Mr. Kohl has set forth succinctly what should be the ideals of every TDM Shop and how the buyer of these vital products can assist in upholding them, bringing about conditions which operate to his own decided advantage of better Tools·Dies·Machines at lower prices.

There are hundreds of TDM Shops whose ideals and operating policies are identical with those set forth by Mr. Kohl; there are probably some—there usually are in every industry—which will do much better for themselves if they adopt these policies, and thus actively participate in the determination of an entire industry to prove the value of the policy: "Not how cheap, but how good."

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AN addition providing 18,000 square feet of space was completed by The Monarch Machine Tool Company in the record time of 35 days. This substantially increases the productive capacity of the company's plant and it now totals 100,000 square feet. In spite of this increase, however, a substantial portion of the plant's production facilities are operating 18 hours per day. Night work has been greatly facilitated by the installation of the newest type of mercury vapor lights which are said to provide "better than daylight lighting" as the night photograph of the new Monarch building herewith suggests.

The Monarch Machine Tool Company, with its plant in Sidney, Ohio, announces the opening of a direct factory office at 3115 North Meridian Street, Indianapolis, Indiana. Hugh W. Robinson, a member of the Monarch organization for some 12 years, has been appointed Manager of the new office.

Stanley Brandenburg has been appointed Monarch representative in New England. After spending three months in Europe as a special Monarch representative, Mr. Brandenburg has established his office in Hartford, Connecticut,

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Torch-cut Arc-weld Method Reduces Time of Die Building

By R. J. FITZSIMMONS, Dist. Manager
Danly Machine Specialties, Inc.

DIE Builders are frequently confronted with a requirement to produce a set of dies in record time. Die sets and parts may be specified to be made of *steel.*

Perhaps the Die Builder is familiar only with *cast* steel. By this method patterns must first be made. The castings are turned out but these must be annealed for several days before they can be machined. A week or more is consumed. The torch-cut and arc-weld method reduces this time considerably.

The development of the cutting torch and the electric arc welder has made several profitable contributions to modern die fabricating practice:

1st—The designer is no longer limited as to the material to be used; types of construction can be used that could not be considered from a foundry standpoint.

2nd—Pattern costs are eliminated—often as much on a single run job as the cost of the part itself.

3rd—Reduced weight and greater rigidity are assured, which are always important factors in operating costs of moving parts under power.

4th—A great saving in time and money is effected. Deliveries can be made on time.

The art of combining torch-cut shapes by electric arc welding with the greatest possible efficiency and economy requires highly trained men possessing an extremely skilled technique, working with highly specialized equipment.

Fabricated parts will function efficiently and in accordance with the original design if subjected to proper heat treatment and normalizing. It is, therefore, necessary to have in addition to skilled welders and special fabricating equipment, furnaces of the latest type (electric or gas) large enough to normalize or stress-relieve any fabricated job. With a skilled heat treating organization properly equipped, such stresses can be completely relieved.

There is much to be said in favor of the torch-cut arc-weld method of die construction.

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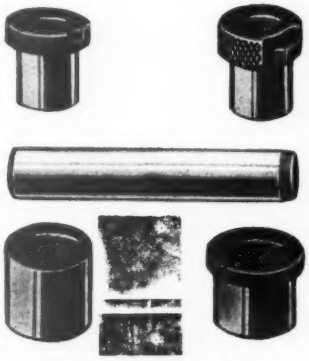

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Modern Tolerance Requirements

(Continued from page 19)

ards Association Committee, it has been decided to discontinue the use of the "no-go" plug gages. In our own factory, we have not used "no-go" plug gages for the past nine years.

In principle, the "go" side, that is the diameter of the inscribed circle, should be measured by plug gages and the "no-go" dimensions by pin gages. See Fig 2. Such a principle gives us the results we must have in order accurately to limit the *makro* errors. There must, however, be some variations in the measuring equipment, depending upon the size of the hole. For very small holes a plug gage should be used for the "go" and a flat gage for the "no-go" side. Obviously, this modification is necessary, since a pin gage of very small dimensions cannot be readily handled. If we use a flat gage, we are at least approaching the requirements which we have laid down for the correct measurement check for the "no-go" limit, and in small holes it proves very satisfactory in practice.

For medium sizes of holes there is no difficulty in using the ideal system of a plug for the "go" and a pin gage for the "no-go." There is one possible disadvantage that must be taken into consideration and that is the fact that, where rings of relatively thin sections are involved, it is possible with a pin gage, when not carefully handled, to make the rings elliptical with only a slight pressure and so obtain an incorrect result. With this thought in mind and a desire to combine, if possible, the advantages of the plug gage as well as the pin gage in one unit, we have developed for our own use, the Te-Bo gage, Fig. 3. The body of this gage is spherical externally and is so made that the diameter of the sphere is the same as the minimum dimension required. Naturally, then, if the diameter of the inscribed circle of the hole is larger than the minimum dimension required, the gage can be introduced into the hole. On the spherical surface near the outer face there is a spherical projection. The distance from the surface of the projection to the diametrically opposite surface of the gaging body is equal to the maximum dimension. The difference between the maximum and minimum dimensions, that is the tolerance, is consequently represented by the height of the projection above the surrounding spherical surface. When the minimum condition is checked, the gage is introduced into the hole with the handle tilted slightly upward. This gives us our "go" reading. For the "no-go" reading the handle is tilted downward, and, if the movement is impeded, the hole is approved. If the

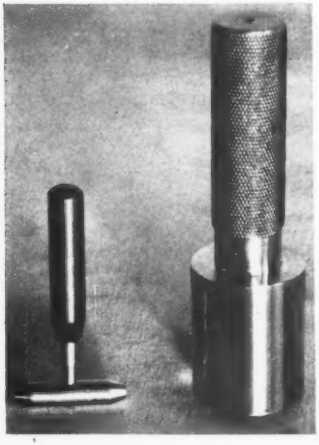
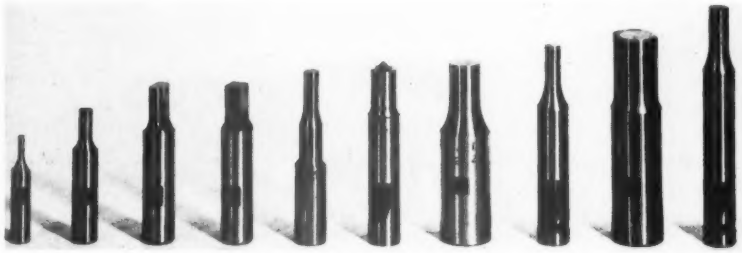


Fig. 2 "Go" Plug Gage and "No-Go" Gage For Correct Principle of Measuring Bores

Fig. 3 Te-Bo Gages

(Continued on page 34)



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Modern Tolerance Requirements

(Continued from page 32

tilting movement is not impeded by the interference of the projection, the hole is too large. By the performance of this simple operation in different positions of the workpiece, the hole is checked throughout.

It is, of course, observed that when the "no-go" dimension is to be checked, the diameter of the body itself prevents the hole from assuming an elliptical shape. Thus, we have combined a simple method of checking the diameter of the inscribed circle and the largest possible diameter in one simple gage, which will insure accuracies undeterminable when "go" and "no-go" plug gages are used. With the gage correctly handled, one is always certain of obtaining the same measuring pressure, i.e., the weight of the gage for the "go" dimension and the weight of the handle for the "no-go" dimension. A modification of the gage for long holes can be made whereby the body can be tilted by means of a special handle with spring action.

When we come to larger holes, gages following the principle of the inscribed circle become too unwieldy and some modifications must therefore be made. Today, the pin gage is generally used for both the "go" and "no-go" limits. These pin gages are always made with very small measuring surfaces. The difficulty of proper measurement with these gages is known to all of us. Furthermore, for the "go" side, only a small part of the hole can be checked, which offers no assurance as to the size of the inscribed circle. There should be no difficulty in improving the accuracy of measurements if the pin gage employs a built-up construction with the ends of pins having mushroom heads. Such a gage is shown in Fig. 4. For the 'go" side the ends have large heads in order to check as large an area of the inscribed circle at one time as possible. For the "no-go" limit, it is desirable to have one end large, Fig. 4, and the other small. The large end enables one to center the gage, providing the contact angle is at least 4 deg. At the other end, a small head is used which enables us to obtain a check for the diametric dimensions.

With equipment of this type, which, as will be observed, takes into consideration only the basic principles of the measurements of the diameter of the inscribed circle and the maximum existing diameter, we shall have gained a better knowledge of what we are doing, and as a result will have improved substantially our manufacturing methods and our products.

For the measurement of the shaft, the principles already laid down require consideration of (1) the diameter of the circumscribed circle, and (2) the minimum existing diameter.

Theoretically, we should, therefore, have a ring gage, the bore of which is made to the maximum limit and the length of which is equal to the length of the surface to be measured. Generally speaking, however, it would be impracticable to use a ring gage and particularly one having a length equal to the length of the measured surface. However, we can, in the design of a snap gage, make the measuring surface of this gage relatively long, and so at least simulate to a degree the theoretical necessity for measuring as great a length as possible.

For the "no-go" dimensions we should have a gage with two points set to the minimum limit, for only by two points can we determine theoretically the absolute diameters. But this is also impracticable, for with two points,

(Continued on page 46)

Fig. 4 Pipe Gage of Built-Up Construction For "No-Go" Dimension

Fig. 5 Snap Gages of Design

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ARE EXCELLENT FOR ALL OPERATIONS
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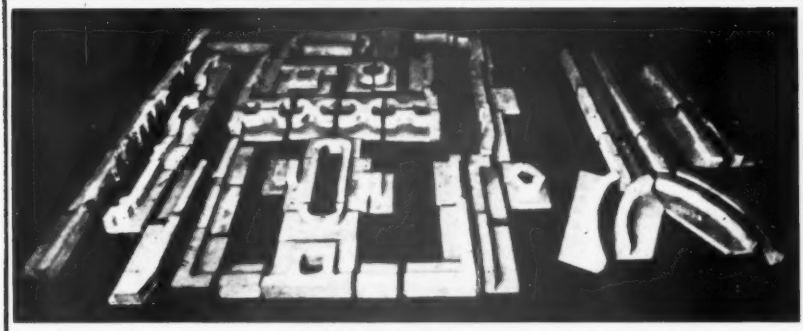

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Hardness Conversion Chart

(Continued from page 22)

gles to each other. The Brinell tests were on steels hardened and tempered under 600 Brinell as inaccurate readings due to deformation of the ball were encountered on steels harder than 600 Brinell. No Brinell readings were recorded on sections where there was a possibility of a flow of metal at the edges or on the back of the piece.

In making the Monotron, Rockwell and Scleroscope tests, sufficient surface on the part being tested was removed by grinding or filing to avoid fluctuations in readings due to rough surfaces caused by rough grinding or coarse machining. Such surface conditions as scale or decarburization were also avoided by grinding. Care was taken to see that the part being tested was level and rested solidly on the anvil or test-table in order to obtain equal support to the penetrator. In cases of round work a small flat spot was ground or filed to avoid inaccurate readings that might be caused by the curved surface of the work.

After more than two years of painstaking effort, we took the averages of the

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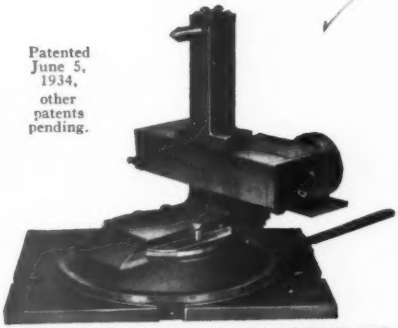
readings obtained on the various types of steels tested on the different hardness testers and made what we considered a universal chart which we could depend upon regardless of the machine upon which the test was to be made or the grade or the type of the steel.

Copies of this chart were first made in mimeographed form but the demand became so great that we had it printed on celluloid and copyright it. (AA-217944)

The Porter Hardness Conversion Chart is available to readers of Tool·Die·Machine PROGRESS upon request. The Editor.

Patented June 5, 1934, other patents pending.



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- **Unusual features include large die space and chrome nickel steel crankshaft.**
- **Produced in sizes from 10 ton to 70 ton capacity and in flywheel, geared, convertible geared and motor driven types.**
- **Distributors in Principal Cities.**

WRITE FOR LITERATURE

MARSHALLTOWN MFG. CO.
913 East Nevada Street
MARSHALLTOWN, IOWA, U.S.A.

New Deckel Type FP1 Universal Milling Machine Unusually Versatile for General Tool and Die Building

THE new Deckel Type FP1 Precision Universal Tool Room Milling Machine is particularly versatile in its application to the manufacture of a large variety of Tools, Dies, Moulds, Gages, Jigs and Punches. Particularly interesting are a number of new mechanical features which it is said, are exclusive with this machine. These are:

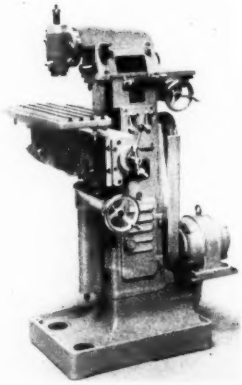
Detachable swiveling work table.
Detachable dividing head with arbor support.
Punch milling device.
Swiveling vertical shaper-slotter with 3" stroke.
Swiveling vertical standard speed milling head in addition to the standard horizontal milling head with arbor support.
Swiveling high speed vertical milling head with self-contained motor drive.

The machine has 6 mechanical cutter spindle speeds and work table feeds and a two-speed, 2HP electric motor provides 12 different speeds and feeds. The swiveling work table and dividing head features permit angular milling, boring and drilling in connection with both the vertical and horizontal cutter heads. Thus it is possible as an example to drill and bore a Box Jig, making use of the end gage blocks and then effect the simple change from horizontal to vertical operation and with the tilting of the working table 180° to permit completion of the Jig without reclamping.

In Mould making, guides set horizontally and vertically enable the machine to be employed as a profile Miller. A beveled face can be milled with straight shank cutter by tilting the vertical cutter head or a cylindrical cutter may be used in which case the work table is tilted.

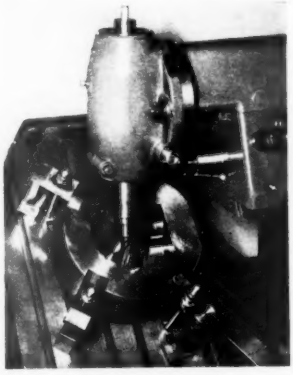
Grooves may be cut in the lower part of a Die Block by setting the slotting device upon the headstock like a vertical milling head. The slotting can then be done directly in connection with milling or boring without reclamping the work piece.

The Deckel Type FP1 Milling Machine has the following dimensions:



Deckel Type FP1 Universal Tool Milling Machine

Milling With Use of Arbor Support



Vertical Milling of a Slant Face With Working Table Tilted by 45°

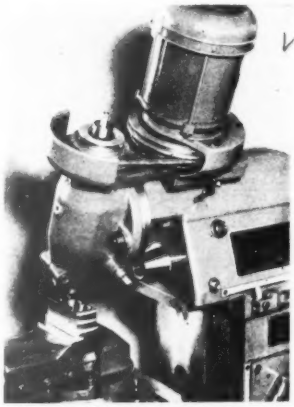
Height of the machine ..... 54″
with vertical milling head ... 60″
Space required .....40″ x 40″
Net weight of the machine approximately .....1040 lbs.
incl. accessories maximum ...1700 lbs.
Weight of packing approximately 560 lbs.
Measures of case .....60″ x 40″ x 34″

The 6 spindle speeds range from 120 to 1200 rpm.

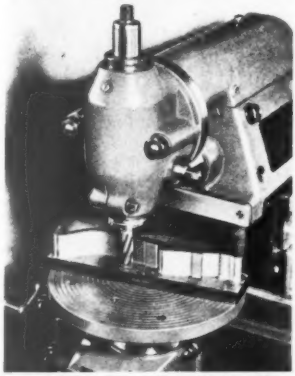
The vertical table has a clamp area 7⅝″ x 20″, horizontally of 9⅞″ and vertically 11⅝″. Large dials permit a reading of .001″ to be made readily. The standard vertical milling head spindle can be swiveled to both sides and adjusted vertically 2⅜″. It is adapted for spring collets up to .700″ bore and the 6 speeds of the spindle range from 190 to 1900 rpm. A high speed vertical spindle is also available with speeds from 1900 to 6000 rpm.

Two swivel horizontal work tables are available with clamping areas of 10¼″ x 17″ and 10¼″ x 24″ respectively, both have 5 T-slots. Table may be swiveled horizontally 30° toward each side, vertically toward each side 45° and 30° forward as well as toward the machine. When swiveled forward this table top may be turned 180°.

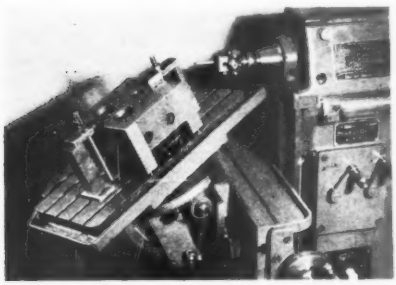
For detail information about the new Deckel Type FP1 Universal Milling Machine, write The H. P. Preis Engraving Machine Company, 159 Summit Street, Newark, New Jersey, and request descriptive circular TD.



High Speed Vertical Spindle Swiveled Sideways While Drilling Oblique Hole .040″ in Diameter

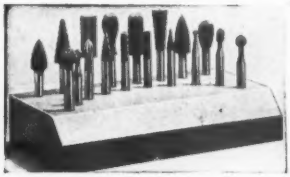


Milling of Blanking Punch by Means of Vertical Cutter Head



Swiveling of the Angular Working Table

Boring Holes to Exact Center Distance. Adjustments by End Gages and Dial Test Indicators



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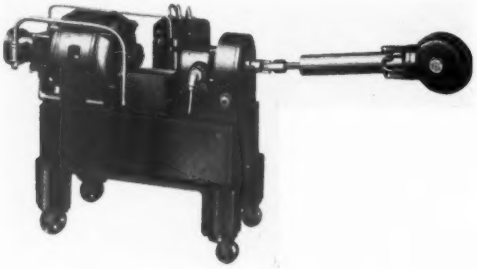
Circular and price list on request.

THE HAMILTON TOOL COMPANY

220-248 North "B" Street Hamilton, Ohio

New Portable Profiling Machine for Die Shops



AMONG the new products recently announced by TDM Industry shops is the Detroit Universal Duplicator, particularly for reproducing the contours of dies, moulds, patterns, etc. Developed over a period of several years by the Giern & Anholtt Tool Co., Inc., of Detroit, Michigan, the device has been thoroughly proven and deliveries begun.

The Detroit Duplicator is a universal attachment for lathes, milling machines and shapers, making of them automatic machines for contour turning, profile milling and contour shaping. This is done by connecting the duplicator through a universal shaft to any lead-screw which controls the contour of the work in process. The cross feed of the machine to which it is attached operates under its own power.

The duplicator's hydraulic power unit is electrically controlled and operates accurately and to close tolerances. An electrical tracer is usually mounted on the column of the milling machine or on lathes and shapers in such a way as to follow the model or master form. This tracer controls the direction of rotation of the power unit and thus reproduces the shape of the model by the cutter.

The device is sufficiently powerful to operate a large boring mill but also sufficiently sensitive to operate accurately with much smaller machine tools. Fig. 2 shows the unit attached to and operating a floor type horizontal milling machine. The Duplicator is a portable device readily movable from one machine tool to another. It is easily installed and operated and its unusually compact design permits its being used between machines already installed.

For additional information write: Giern & Anholtt Tool Co., Inc., 1310 Mt. Elliott Avenue, Detroit, Michigan. Circular TD will be sent upon request.

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New Quick Action Vise

THE Knu-Vise, herewith illustrated, is a knuckle-action or toggle type vise for use in drilling, tapping, milling, reaming, countersinking and similar operations. The operating mechanism which is made of tool steel exerts a tremendous pressure upon the piece which is being machined. Comparatively little effort is required in the use of the handle to assure this accurate, rigid clamping of the work.

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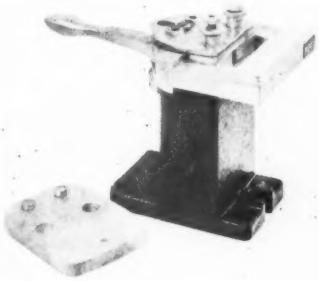

The Knu-Vise Products Company, 6430 Cass Avenue, Detroit, Michigan, is the manufacturer, and requests mentioning this article will bring detailed descriptive matter and prices.

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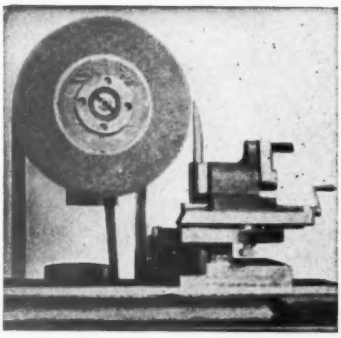

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Cobly Universal Vertical Miller-Shaper Has Important New Features

SHAPING punches from the rough without undercutting is one of the operating features of the Cobly Universal Vertical Milling and Shaping Machine. It is accomplished with a radius tool attachment which fits the shaper ram in place of the clapper block.

Located on the compound circular table as shown in Fig. 1 the punch can be machined on all sides and from any center within a 5-inch circle, developing true radii, tangent and angular cuts with a high degree of accuracy. For machining the die opening with the standard tool holder, the table settings for the punch can be duplicated.

The Cobly Miller-Shaper has several other new improvements to its credit. It has been provided with a high speed spindle mounted in anti-friction bearings, and having ten right-hand speeds with a high of about 2100 R.P.M. The spindle is equipped with a sleeve to hold split collets from 1/8" to 5/8" thus eliminating the need for a high speed attachment. This spindle is equipped either with or without power down feed with four changes applicable to any spindle speed. The feed has an automatic stop and a

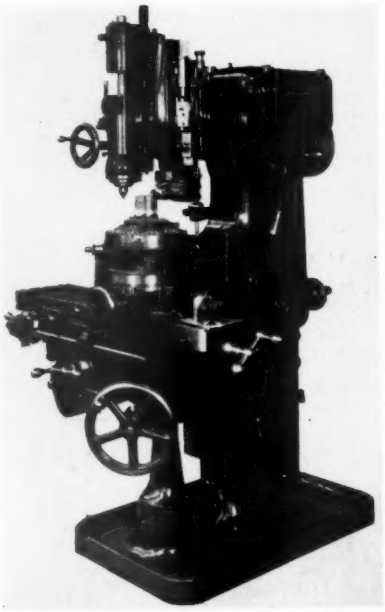
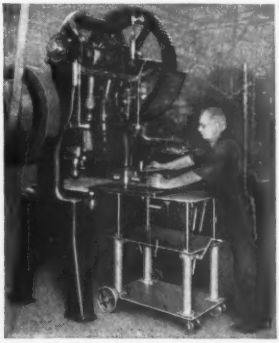


Fig. 1



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micrometer screw for gaging depth.

A close-up view of the table in Fig. 2 shows a P. & W. system of end gages, micrometer and dial gages reading to .0001. This is used for accurate setting of the table for boring holes in Dies, Jigs, Gages, Fixtures, Moulds, etc., also on milling and shaping operations. The table can be arranged to receive a 10" universal dividing head as shown in Fig. 1.

The milling and shaping heads adjust at any angle right to left, or left to right from vertical to horizontal and 45 degrees front and back from center for drilling, milling, boring, shaping and slotting operations. There are constant power feed for milling, and intermittent feed for shaping, and applying to the longitudinal, transverse and circular movements of the table, thus making a wide variety of work, including spiral gears and cutters, possible on this Universal Miller-Shaper.

The machine and attachments are built by the Cochrane-Bly Co., Rochester, N. Y., and additional information may be had by addressing Department TD.

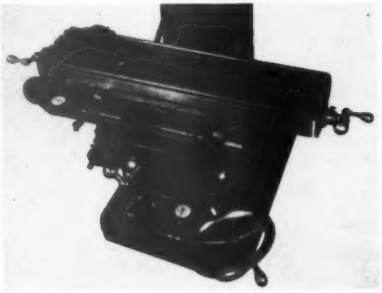

Fig. 2

Punches Shaped From the Rough Without Undercutting on the Cobly Universal Miller-Shaper

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New Grand Rapids Surface Grinder Has Infinite Variation of Table Speeds

MORE than 25 years of experience in the building of precision grinding equipment are built into the newest of the Grand Rapids line of Hydraulic Feed Surface Grinders. This new grinder is a High Speed Cross Traveling Head Type with an infinite variation of table speeds from the very slowest possible movement to a maximum of 150 feet per minute.

The two photographs reproduced herewith are views of the machine with a 16″x48″ working surface of table. Other table dimensions are available.

The base of the machine is a heavy, one-piece casting twice the length of the working surface of the table, thus assuring no overhang in normal operation.

The upright column which carries the vertical sliding head is a one-piece casting with exceptional rigidity. It is keyed, bolted, and doweled to the base member in such a way that these two castings are in effect, one.

The starting and stopping of the table and the control of operating speeds is by means of the lever in the center of the front valve plate.

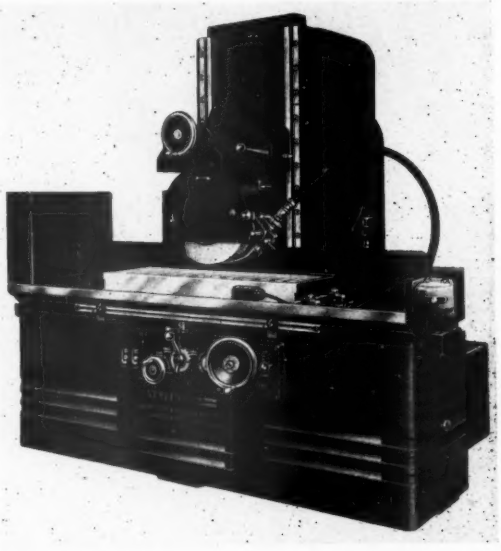
The cross traveling spindle slide has a movement equivalent to the working surface of either 16″ or 18″, thus a 4″ standard width of wheel overruns the working surface 2″ on both the front and back edges of the table.

The cross traveling movement normally operates with each reversal of the table and the amount of movement can be set from less than 1/32 of an inch to 2″ with each reciprocation of the table. The total amount of cross travel in a given direction can be governed by adjustably positioned dogs. When the desired amount of cross feeding has taken place in one direction, the table will automatically reverse and cross travel in the opposite direction. A convenient lever is provided for reversing the cross travel by hand if it should be desired to do so before the reversing dogs have contacted the reverse mechanism.

The standard spindle construction is of a special ball bearing, flanged type with an adjustable amount of "pre-load." Experience indicates that the quality of the grind these bearings will give is at least equivalent to that of the best bronze bearing and that the length of service is greater than that of the bronze bearing before it will need re-scraping and re-fitting.

The standard spindle drive is by means of a 1150 R.P.M. 25 H.P. motor which drives directly through a splined end. Thus the cross traveling mechanism is relieved of carrying the weight of the motor which is mounted in a fixed position on the vertically traveling head member.

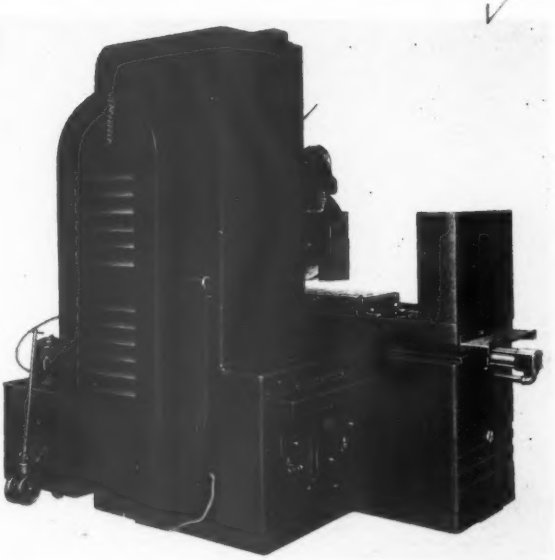
Vertical movement of the wheel head, in actual grinding operations, is con-



trolled by the large hand wheel in the front of the base just to the right of center. This is graduated in .0001".

Power elevation of the vertically moving head slide is provided by a ½ H.P. motor which is controlled by a double throw switch at the right of the central valve plate.

Complete wet grinding equipment providing an adequate flow of coolant is standard equipment. The coolant tank is positioned in the corner formed by the rear of the base and the upright column at the right hand side. It is a separate portable unit on rollers which facilitates its handling for removing accumulated grit and dirt. The copious flow of coolant, essential for satisfactory grinding on this type of machine, is pumped by an independent motor mounted on top of coolant tank. The hydraulic oil supply tank is mounted in the base with convenient access for filling, draining, and checking the supply.

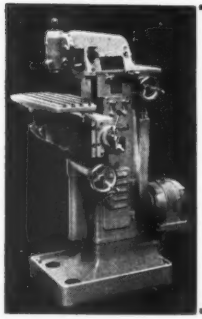


A pressure gage continuously registering the hydraulic pressure is provided in the main valve plate to the right of the center.

Automatic forced feed lubrication of the table ways is provided from the pressure line. All other points requiring lubrication are provided for by the Bijur one-shot lubricating mechanism.

All operating controls are in the center of the base, easily accessible to the operator while standing in one position. Push button switches controlling the spindle motor and the hydraulic pump motor are to the left of the front valve and the coolant pump motor and vertical power traverse of the wheel head are to the right of the vertical movement hand wheel.

Grand Rapids Surface Grinders are a product of Gallomeyer & Livingston, Grand Rapids, Mich. A new catalog TD will be mailed on request.



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Modern Tolerance Requirements

(Continued from page 34)

it is difficult to locate a real diameter.

Fig. 5 shows a snap gage of a new type which takes the foregoing problems into consideration. On one side is a flat surface, which can be regarded as the measuring table for both "go" and "no-go." On the other side, the "go" is made as a projection, consisting of a part of a cylinder which runs the entire width of the gage. For the "no-go" one or two spherical knobs are provided, which will then measure the smallest diameters on the work piece.

There is still a further consideration, and that is, What measuring pressures shall we use? In this country, I believe, snap gages are generally of very much heavier section than the gages used in most other countries, and so the springing of the measuring surfaces is limited. However, even with this rigidity, it is quite possible to obtain a spread of the jaws which may be from 0.0001 in. to 0.0002 in. or more. I do not know that there is any settled practice, but it might be concluded from the snap gages I have purchased and examined, that they are so set that the dimensions prescribed are maintained only at no load. When we remember that the normal forces which tend to spread the gage are from four to six times greater than the tangential measuring load, it is easily understandable why this spread of the measuring surfaces exists and why limit dimensions under load must be considered.

It is probably also a fact the surfaces are adjusted parallel at no load. When any spread takes place, these surfaces are no longer parallel, and not only has the effort and expense necessary to produce parallel surfaces been lost, but, obviously, the accuracy of the gages themselves. To correct this condition, I have proposed using for the "go" side a combination of line and surface contacts which will always be parallel, no matter what the spread may be, and for the "no-go" side a combination of point to surface . . .

How are we to determine accurately what this shall be? Certainly it seems desirable to have a standard in order to set the gages under the necessary measuring pressure. An instrument for carrying out this measurement effectively consists essentially of a balance with the gage itself on one arm, counterbalanced by a variable weight on the other. A reference disk is now placed in position and the gage may be checked so that it just passes the disk when the prescribed load is added.

In our own plant, because of the relatively thin sections of the products which we make, we have found it necessary to use as our basis a very limited measuring load of 100 g, and all of our snap gages are set under this load. In our gage room we have a number of these balances, and they are also available in the various production departments . . .

These seemingly minor changes in equipment for the measurement of the bore and the shaft give us astounding results. I am quite safe in saying that were these changes made in the average plant it would immediately mean a rejection of 30 per cent of the parts which are now passed as "satisfactory" under the ordinary gage methods.

There has always been a divergence of ideas between the engineer and the shop superintendent. On the one hand, the engineer, from past experience and past trouble, is anxious to limit and reduce the tolerances without definite knowledge as to whether or not the tolerances which he has specified are actually being observed in shop practice. The shop superintendent, on the other hand, must consider many practical manufacturing problems, the characteristics of his equipment, and a variety of the limitations with which he may be surrounded.

A common understanding *can* be obtained by a better knowledge of exactly what is being done and what can be done in the shop but this is only possible by accurate gaging technique. Use of the new principles and methods of measuring which I have described may, in some cases, mean a change, or the broadening out, of present tolerances to enable the shop to do what the engineering department thinks is required. Such a fundamental change is not a matter of days or weeks, but will require several months or even years. Once it has been accomplished, it may be possible to use some system of designation or nomenclature which, in turn, may further assist in that for which we all strive—a thorough understanding between engineering and manufacturing in their common problems.

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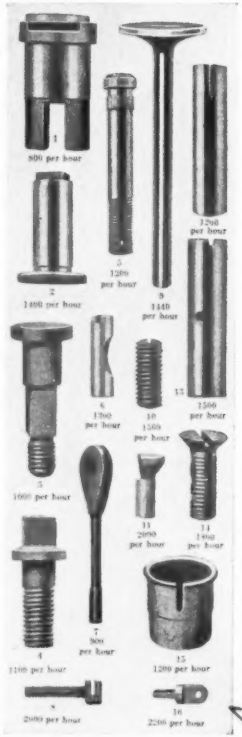

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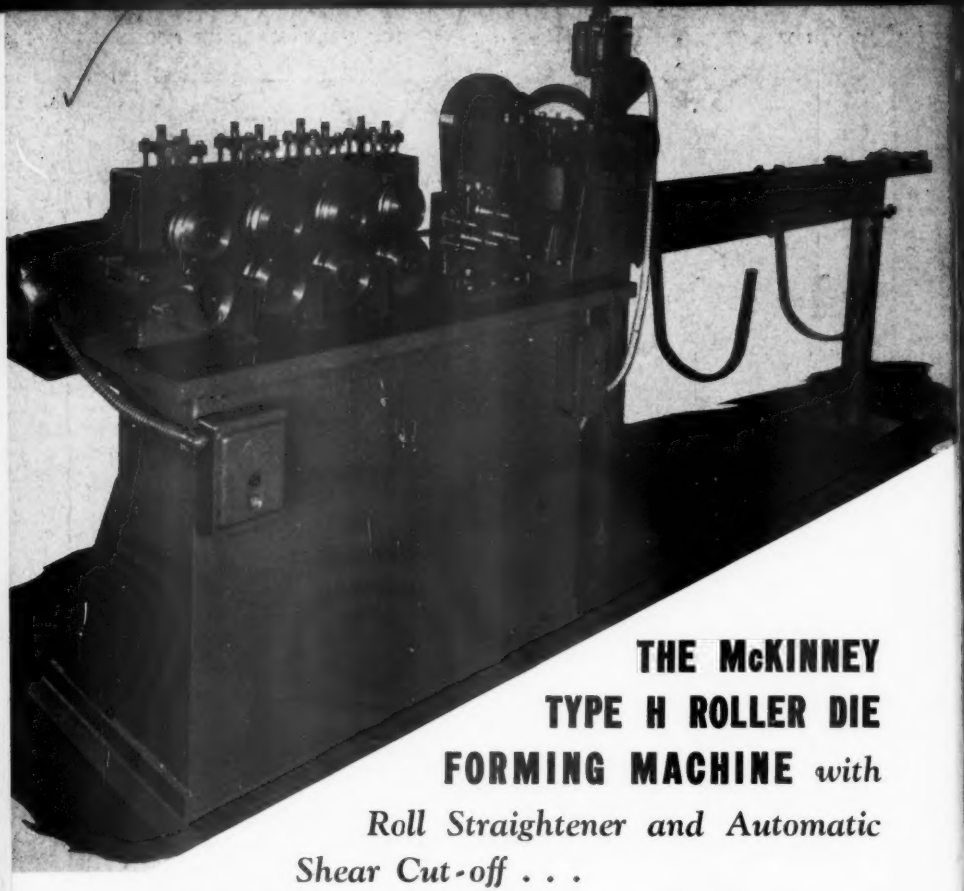

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